Instructions

Work on in groups of up to four people (I think three to a group is optimal, but you can have a group of four if you like). Each groups turns in one solution, all members of the group will receive the same grade.

Use complete sentences and correct grammar to explain your solution. Diagrams should be neat and well-labeled. Make your solution complete and easy for a reader to follow–do not leave gaps in the solution where the only way a reader could understand it is if they had already solved the problem themselves. The audience for your solution is a friend in the class, not an instructor who already knows the solution!

Any *Mathematica* you use can be printed out and included in your solution. Delete any unnecessary *Mathematica* output before you print, and feel free to add annotations by hand to help explain the *Mathematica* commands you used (not an explanation of syntax, but rather what each command helps you with in the process of solving the problem). **DO NOT** print out 10 pages of cryptic *Mathematica* output! Your job is to explain all components of your solution

Two Geometric Methods for Computing Tangent Lines

There are other ways to compute the equation of tangent lines than what we have seen in class using limits. Although this applied project is not applying calculus (which we haven't developed yet!) to a problem, it will give you an opportunity to apply your problem solving skills to a concept which motivated the study of calculus.

This project explores two geometric methods for determining tangent lines–the method the Greek philosopher Apollonius of Perga (ca. 262 BC ca. 190 BC) developed for finding the tangent line on a parabola (he also developed methods for ellipses and hyperbolas), and the method developed by French philosopher René Descartes (1596 - 1650) which works for any function.

The method of Apollonius is described with some very nice diagrams here: http://hom.wikidot.com/apollonius-methods

The method of Descartes is described very well here: http://hom.wikidot.com/descartes

1. Use Apollonius' method to determine the tangent line to the parabola $y = \frac{x^2}{4} + 1$ at the point $(4, 5)$. Include a well-labeled sketch drawn by hand, and explain the steps you used to find the equation of the tangent line.
2. Use Descartes' method to determine the tangent line to the parabola $y = \frac{x^2}{4} + 1$ at the point $(4, 5)$. Include a well-labeled sketch drawn by hand, and explain the steps you used to find the equation of the tangent line. You will want to do the algebra with the assistance of *Mathematica*, as the Descartes method is far more involved that the Apollonius method.
3. Use *Mathematica* to plot both the parabola, tangent line, and circle from Decsartes' method on the same set of axes.

If you are interested, Google books has an English translation of Apollonius' *Conics*–check out page 254 (of the pdf) Proposition 47 and page 207 Proposition 12 for the tangent to a parabola:
http://www.wilbourhall.org/pdfs/Treatise_on_Conic_Sections.pdf.

Project Gutenberg has Descartes' *Discourse on the Method of Rightly Conducting One's Reason and of Seeking Truth*
http://www.gutenberg.org/ebooks/59